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Professor Tait, in a recent number of *Nature* (Nov. 25, 1880), directs attention to the necessity of perfect definiteness of language in all scientific work. "Want of definiteness," he says, "may arise from habitual laziness, but oftener indicates a desire to appear to know, where knowledge is not."

It is also claimed that scientific writers, even of the present day, have not that clear comprehension, which is essential, of what is subjective and that which is objective, and thus much confusion arises. To use Professor Tait's own language, our only source of information in physical science is the evidence of our senses. To interpret truly this evidence, which is always imperfect and often wholly misleading, is one of the tasks set before reason. It is only by the aid of reason that we can distinguish between what is physically objective and what is merely subjective. Outside us there is no such thing as noise or brightness; these no more exist in the aerial and ethereal motions, which are their objective cause, than does pain in the projectile which experience has taught us to avoid. To arrive at the objective point of Professor Tait's article, we may state that it involves a disagreement between himself and Mr. Herbert Spencer, as to the real meaning of certain words, and the propriety of making use of them on occasions which are mentioned.

In one of his works, Mr. Spencer states that, "Evolution is a change from an indefinite, incoherent homogeneity, to a definite heterogeneity, through continuous differentiations and integrations."

Mr. Kirkman translates the foregoing into "plain English," or as Professor Tait rather profanely asserts, "strips it of the tinsel of high flown and unintelligible language," thus:

"Evolution is a change from a nohowish, untalkaboutable, all-alikeness, to a somehowish and in-general talkaboutable not-all-alikeness, by continuous somethingelsifications and sticktogetherations."

Mr. Spencer claims that the explanation of the meaning of the word "Evolution" is a formula. Professor Tait calls this "a definition;" hence the difference of opinion, the latter asserting it to be not a mere quibble of words, but that an important scientific distinction is involved, to which the attention of the scientific world is directed.

The perusal of a communication from Professor Asaph Hall, of Washington, which will be found in this column, will greatly assist those who desire to solve the question. Professor Hall does not enter into any details of the controversy, but offers "*an illustration*" which appears to strike at the root of the matter in dispute.

We think that Mr. Spencer may rest satisfied with applying the term "*definition*" to his form of words, for by the rule presented by Professor Hall, it is evidently straining a point to assert that in them we find "a *formula*," using that word in the same sense as when we speak of the law of gravitation.

By the law of gravitation astronomers are able to predict the positions of known celestial bodies four years before the event, and Professor Tait asks if Mr. Spencer, with his "formula," can predict, four years before hand, the political and social changes which will happen in the history of Europe.

AN ILLUSTRATION.

In regard to the controversy between Professor Tait and Mr. Herbert Spencer, I beg to offer the following illustration. If we take by chance the three numbers 11, 12, 13, and form their squares, we have

$$(11)^2 = 121$$
$$(12)^2 = 144$$
$$(13)^2 = 169$$

Now take the numbers with the figures in an inverted order, and we have,

$$(11)^2 = 121$$
$$(21)^2 = 441$$
$$(31)^2 = 961$$

We see that the figures of the squares are also inverted; and this holds in the case of three consecutive numbers. We infer therefore that this is a general law in the formation of square numbers. Arguments of this kind might have an extended application in various branches of science; but if we make further examination we soon find numerous exceptions to our

law, and we conclude finally that, although in the common phrase there may be something in it, yet our assumed law is in fact no law at all.

Again I examine my table of squares, and I find a rule of this kind: The second differences of the squares are constant, and equal to 2. I make many trials of this rule and never find an exception. Others do the same and always the same result is found. We conclude therefore that we have at length discovered a real law that exists in the formation of squares; but at the same time we invite every one to make the examination for himself, and if possible to find an exception. A. HALL.

Washington, D. C., December 17, 1880.

PROFESSOR TAIT AND MR. HERBERT SPENCER.

In another column we have referred to the controversy between Professor Tait and Mr. Spencer. Since this was put in form we have received a copy of Mr. Spencer's reply and, with pleasure, give his own explanation, which appears in *Nature* of the 2d instant:

"I pass now to his implied judgment on the formula, or definition, of Evolution. And here I have first to ask him some questions. He says that because he has used the word 'definition' instead of 'formula,' he has incurred my 'sore displeasure and grave censure.' In what place have I expressed or implied displeasure or censure in relation to this substitution of terms? Alleging that I have an obvious motive for calling it a 'formula,' he says I am 'indignant at its being called a *definition*.' I wish to see the words in which I have expressed my indignation; and shall be glad if Prof. Tait will quote them. He says—'It seems I should have called him the *discoverer of the formula!*' instead of 'the inventor of the definition. Will he oblige me by pointing out where I have used either the one phrase or the other? These assertions of Prof. Tait are to me utterly incomprehensible. I have nowhere either said or implied any of the things which he here specifies. So far am I from consciously preferring one of these words to the other, that, until I read this passage in Prof. Tait's lecture, I did not even know that I was in the habit of saying 'formula' rather than 'definition.' The whole of these statements are fictions, pure and absolute.

"My intentional use of the one word rather than the other, is alleged by him *àpropos* of an incidental comparison I have made. To a critic who had said that the formula or definition of Evolution 'seems at best rather the blank form for a universe than anything corresponding to the actual world about us,' I had replied that it might similarly be 'remarked that the formula—"bodies attract one another directly as their masses and inversely as the squares of their distances," was at best but a blank form for solar systems and sidereal clusters. Whereupon Prof. Tait assumes that I put the 'Formula of Evolution alongside of the Law of Gravitation,' in respect to the definiteness of the provisions they severally enable us to make; and he proceeds to twit me with inability to predict what will be the condition of Europe four years hence, as astronomers 'predict the positions of known celestial bodies four years beforehand.' Here we have another example of Prof. Tait's peculiarity of thought. Because two abstract generalizations are compared as both being utterly unlike the groups of concrete facts interpreted by them, *therefore* they are compared in respect to their other characters.

"But now I am not unwilling to deal with the contrast Prof. Tait draws; and am prepared to show that when the conditions are analogous, the contrast disappears. It seems strange that I should have to point out to a scientific man in his position, that an alleged law may be perfectly true, and that yet, where the elements of a problem to be dealt with under it are numerous, no specific deduction can be drawn. Does not Prof. Tait from time to time teach his students that in proportion as the number of factors concerned in the production of any phenomenon becomes great, and also in proportion as those factors admit of less exact measurement, any prediction made concerning the phenomenon becomes less definite; and that where the factors are multitudinous and not measurable, nothing but some general result can be foreseen, and often not even that? Prof. Tait ignores the fact that the positions of planets and satellites admit of definite prevision, only because the forces which appreciably affect them are few; and he ignores the fact that where further such forces, not easily measured, come into play, the previsions are imperfect and often wholly wrong, as in the case of comets; and he ignores the fact that where the number of bodies, affecting one another by mutual gravitation, is great, no definite prevision of their positions is possible. If Prof. Tait were living in one of the globular star-clusters, does he think that after observations duly taken, calculations based on the law of gravitation would enable him to predict the positions of the component stars four years hence? By an intelligence immeasurably transcending the human, with a mathematics to match, such prevision would doubtless be possible; but considered from the human standpoint, the law of gravitation, even when uncomplicated by other laws, can yield under such conditions only general and not special results. And if Prof. Tait will deign to look into 'First Principles,' which he apparently prides himself on not having done, he will there find a sufficient number of illustrations showing that not only other orders of changes, but even social changes, are predictable in respect to their general, if not in respect to their special characters."

REVERSION IN FLORAL PARTS.

By WILLIAM A. BUCKHOUT.

One of the best plants for showing the reversion of floral parts to the form of leaves is the common red field-clover (*Trifolium pratense.*)

It is always easily obtained, and during the fall of the year these heads of reverted flowers are quite common. The pedicels of the flowers are much elongated, and somewhat reduced in number; hence the heads have a loose appearance, which, with their very leafy look and absence of color, makes them conspicuous among

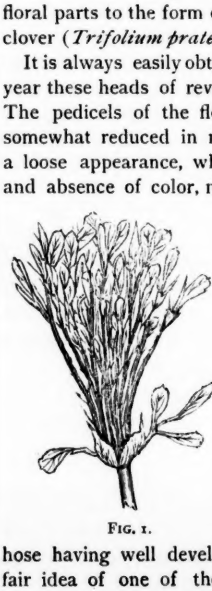

FIG. 1.

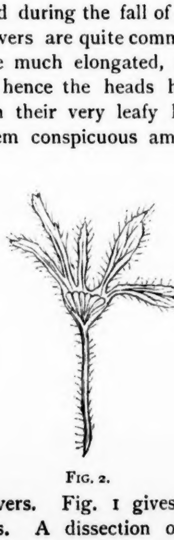

FIG. 2.

hose having well developed flowers. Fig. 1 gives at fair idea of one of these heads. A dissection of a

flower shows that all parts have changed, and are decidedly leaf-like, though not to the same extent. Of the sepals (Fig. 2.) two are larger than the others, are very distinctly veined, and have a few small teeth near their tips; the remaining sepals are narrow, elongated, and have only the midrib without any lateral veins. The petals have lost their papilionaceous character entirely, though the vexillum may be recognized by its larger size. Each petal (Figs. 3, 4.) is leaf-like in shape, veining, and especially in the possession of a pair of stipules which are fused with its base precisely, as are the stipules of the leaf proper. The petals project but slightly from the tube of the calyx.


Fig. 3.


Fig. 4.

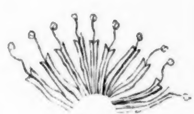
Fig. 5.

The stamens (Fig. 5.) are not diminished in number, but are separate, and each filament bears the stipules distinctly. They are joined with it nearly to the anther. This would seem to indicate that the sheath of united stamens in the *Leguminosæ* is made by the fusion of the stipular elements of the leaf alone.

Within the stamens, and occupying the centre of the flower, is a single, rather long-stemmed leaflet, apparently the middle one of the three so characteristic of the trifoliums. It is unmistakably a leaf in its veining, outline, color, etc., and upon its petiolar portions are borne —as might be expected—the stipules; in this case as plainly stipules as those which are borne by the true foliage leaves. No trace of a pistilline nature is to be seen. The reversion has been complete. All the parts, except the stamens are exceedingly hairy.

The peculiar feature in this case is the retention of the stipules as separate parts in all the whorls, excepting the calyx, where they are undistinguishably fused to form the cup-like portion of that organ.

The ease with which these reverted flowers can be obtained and studied, and the light which they throw upon the morphology of the parts of the flower make them worthy the attention of students who ought, as soon as possible, to gain a practical knowledge of the real nature of floral parts.

A demonstration in mathematics could not be more conclusive than this lesson from *Trifolium pratense*, our familiar red clover.

Pennsylvania State College, Dec. 20, 1880.

THE CLASSIFICATION OF SCIENCE.

By Rev. Samuel Fleming, LL. D., Ph. D.

I.

DEFINITIONS.

The term science has been variously defined. It is from the Latin *scientia* (from *scio*, I know,) which is defined as "a knowing, or being skilled in anything; generally, knowledge, science." The original sense of the term *scientia* involves the twofold conception, of the *thing*, or fact itself, which is the subject of knowledge, and the *knowing* the fact. The former is the *objective* signification, the latter the *subjective*. In defining the term, therefore, diverse forms of expression have been used, and different senses conveyed. In the edition of Webster's Unabridged Dictionary, published in 1878, modified definitions are given as follows: "Knowledge; the comprehension of truth or fact; truth ascertained; that which is known; hence, specifically, knowledge duly arranged, and referred to general truths on which it is founded." By some, the definition given is "systematic knowledge"; by others, "what is comprehended by the mind"; another definition is in the following language: "Science is the name for such portions of human knowledge as have been more or less generalized, systematized and verified." Herbert Spencer gives the following, corresponding with the general divisions of his "Classification of the Sciences": 1. That which treats of the forms in which phenomena are known to us; 2. That which treats of the phenomena themselves. Prof. Tice, after stating that "there is a broad distinction between knowledge and science," gives this distinction in the following terms: "Knowledge is a clear and certain perception of that which exists, or of truth or of fact. Science is a body of general principles: particular truths, and facts, arranged in systematic order."

The terms science and knowledge have sometimes been used as synonymous; frequently without due discrimination. It is evident that the facts of science, if not science itself, exist prior to, or irrespective of the mind which acquires the knowledge of them, if we except the science of the mind itself. Existence is one thing, the knowledge of such existence is radically another thing. Hence the propriety, and often great importance of recognizing this distinction, and of discriminating in the use of the terms. Scientific terms should be used with definiteness of meaning, for clearness and conciseness of written or oral instruction. If science and knowledge are synonymous terms, if the definition "science is knowledge" is the same with the terms transposed, thus "knowledge is science," every child and uneducated person who knows that "fire burns," is a scientist, without, it may be, knowing what fire is, or its causes. Then science would signify no more than knowledge. But all fundamentally distinctive ideas are appropriately expressed by different terms. And it is desirable that the demands of language be recognized, and this practical rule for the use of discrimniating words be observed. Synonymous words are properly those which are derived from different languages, and are used for euphony, or variety.

Further, there is a legitimate distinction between common, obvious, or non-scientific knowledge, and scientific knowledge. And this is not a distinction in respect to certainty; for common knowledge is often as certain as scientific knowledge, as in reference to the fall of a body to the earth: while much that is called scientific knowledge is far from being exact in its complete sense, as in respect to the nature of the ultimate cosmic forces, the aurora borealis, and other phenomena. Nor is it a difference simply in degree of knowledge, but a difference also in respect to kind and quality. Thus two persons may observe an eclipse of the sun or moon; one may know only that one body intercepts the light of another body; the other person may know the causes, the sizes, the distances, orbits, periodic times, laws of motion, and many other elements whose knowledge is essential to the determination of the phenomenon. The attainments respectively differ,—the former having only the knowledge of a single fact, the latter the knowledge of the whole system of facts, principles and laws pertaining to the phenomenon; the former possessing ordinary knowledge, the latter scientific knowl-

edge. The distinction is therefore fundamental, and should be recognized as really as other differing facts.

These may be regarded as extreme cases, and it may be said that the point of transition, or the boundary line between the non-scientific and the scientific may not be clearly determined. Be it so; the claims of science require exactness of knowledge to the extent to which the exactness may be obtained by observation or reasoning, and to which the facts themselves fix the standard. And though perfection is the standard and aim, the knowledge of a sufficient number of related facts constituting a systematic knowledge, or knowledge sufficiently "generalized, systematized, and verified," for the comprehension of the relations and laws pertaining to such facts, may be received as evidence of scientific attainment, and capacity for intelligent progress. A man may possess a practical knowledge of carpentry, by which he may perform work, when a frame is "laid out," without the scientific knowledge of the principles, rules or methods by which such work is planned; much less without the higher mathematical and mechanical knowledge of architecture.

Another point of distinction claims attention. The term science is used in both a general, and a special or restricted sense. Either the whole body or aggregate of facts throughout the whole range of phenomena, relations, laws and applications, is referred to comprehensively, as "The classification of all science"; or, a branch or sub-science is referred to specially, as "The Science of Chemistry." Frequently a special science is recognized by the form of statement implying that to which reference is made, the term science being used by metonomy for *a* science, or a particular branch of general science, thus: "Science [chemistry] teaches that all masses of matter are made up of elements which had previously been isolated or separate." Or this: "Science [the science of the conservation of the forces] teaches that a certain quantity of heat may be changed into a definite quantity of mechanical work; this quantity of work can also be re-transformed into the same quantity of heat as that from which it originated." It may be added that the term science is sometimes used in an indefinite sense, or without precision, as "a man of science",—one who possesses a wide range of knowledge.

These distinctions between knowledge and science, between non-scientific and scientific knowledge, and between the special and general significations of the term science, being recognized, it remains only to give such forms of definition as shall meet the requirements of the case. The following are believed to be sufficiently precise:

1. Science (special or particular) is a system of phenomena, principles, relations and laws pertaining to a special subject.

2. Science (general or universal) is the aggregate of special sciences.

Many attempts have been made to classify the various sciences. The conception that they are naturally related, intimately, or more remotely, having general or special connections, has led to such arrangement of these in departments and groups as has accorded with the fundamental principles upon which they have been conceived to be allied. And since science consists chiefly of the facts, phenomena, laws, and principles, material or immaterial, which pertain to being, or the forms in which being is known, it is evident that schemes of classification will be adopted according to the systems of philosophy maintained by those who construct them. All classification will hence be observed to conform in general principles of structure to one or another of the three following systems of philosophy with respect to existence, or entities, viz.: Spiritualism, Materialism or Dualism. The first, which includes Idealism, rejects the doctrine of material essence, mind only being held to be fundamental and real—the outer world only phantasmic or apparent, or as held by some, matter being a mode or manifestation of mind. The second rejects the doctrine of a spiritual entity—the mind or spirit being held to be a phenomenon of matter; force, life and mind being but properties, or special manifestations of matter. Both the above systems are monistic, one substance, or essence, only held to exist. The third maintains the real existence of both matter and spirit in essential connection, yet distinct and unlike, not only in essence, but in their laws of development and modes of action—two related yet diverse processes. This may be termed *Dualistic Realism*, in contradistinction to the *Monistic Realism* predicated of each of the two former systems above mentioned.

But so diverse and even contradictory, in important respects, are many of these schemes of classification, that the question may be asked with pertinence, is any unexceptionable classification possible? Indeed, it has been admitted by men of high scientific standing that the most perfect classification will contain some incongruities and minor imperfections; and that a system substantially correct may, notwithstanding, contain something which is artificial, or merely theoretic. An apparent incongruity may be explained by the fact that several of the sub-sciences bear relations to different and widely separated sciences as to their fundamental characteristics, as will be observed in the scheme of the writer of this article.

A few diverse schemes are here given to illustrate the fact that one's philosophy will determine his principles of classification.

The fundamental principle of Oken, a German philosopher, is, that "Mathematics is the universal science," and holding the transcendental idea that Mathematics is zero, equal to nothing (0), has constructed his scheme to embrace three general classes, viz.: 1. *Mathesis*, the doctrine of the whole; 2. *Ontology*, erroneously defined to be "the doctrine of the *phenomena of matter*," or what seems to be, consistently enough with his doctrine of Idealism; 3. *Biology*, all orders of life and mind. Included in class first he has two groups: 1st. *Pneumatogeny*, the doctrine of immaterial totalities; subjects arranged in the following order: Primary Art, Prim. Consciousness, God, Prim. Rest, Time, Polarity, Motion, Man, Space, Point, Line, Surface, Globe, Rotation. Group 2d, under the term *Hylogeny*, defined to be "the doctrine of material totalities," includes the following: Gravity, Matter, Ether, Heavenly Bodies, Light, Heat and Fire. Included in Ontology he has Rest, Centre, Motion, Line, Planets, Form, Planetary Systems, Comets, Condensation, Simple Matter, Elements, Air, Water, Earth, Mineralogy, Geogony, etc. Other divisions of this anomalous system are here omitted. The author has conceived of a phenomenal process, which is given under the term Ontology, but which, so far as it represents the facts, pertains to cosmogony. It will be observed, moreover, that the place of geogony, to represent a consecutive order, is at the point where the genesis of the earth is given, if it can be found. But this system is based upon the fundamental principle of mathematics, which, according to the author, is zero = 0; for, as it is assumed, "Mathematics is the universal science of forms without substance." Such a system of nothings, consisting of terms, names and propositions, without realities, may well be termed Idealistic Nihilism!

The philosophy of Hegel is founded upon the theory that the essence of the universe is a process of thought from the abstract to the concrete. His classification is based upon Logic, as its fundamental principle, instead of Mathematics, which is Oken's, with which it otherwise well corresponds. A quotation from President Hopkins, that "Classification is a law of *forces*, not a law of logic," may here be given as a sufficient answer to Hegel's principle.

The method of M. Compte, the author of "The Positive Philosophy," gives what he calls "The one rational order," as follows: Mathematics (including mechanics),

celestial and terrestial physics, chemistry, physiology and social physics. In its general outlines, it is a near approach to the proper order; but, in its special application and interpretation, it is a statement of the philosophy contained in his celebrated work just referred to. In that he gives his theory in the following statements: "Our study of nature is restricted to the analysis of phenomena, in order to discover their laws, and can have nothing to do with their nature, or cause, or the mode of their production." The question is suggested, What is the province of philosophy, if not to explain such nature, cause, and mode of production? He opposes "all inquisition into the essence of things;" rejects all hypotheses of "electric fluids and luminous ethers which are to account for the phenomena of heat, light, electricity, and magnetism." He denies that there can be any such thing as internal observation of the mind, or any knowledge of the causes of phenomena. What does he mean by mind? and how does he know that there are other minds than his own, or what is so called, to study his Positive Philosophy! He defines *law* to be "a constant relation of succession or similitude," and ignores all causes operating in matter, and o course there are no such entities as force, life or mind, human or divine.

In his subdivisions and groups, many incongruities are found, the statement of which must here be omitted. The subject matter of concrete mathematics, which is composed of plane geometry and rational mechanics, he has stated to consist of space, time, motion, and force, whose nature, indeed, may not be inquired into. He undertakes to classify the science in the order of historic development, or progress, which cannot be substantiated. Thus, historically, geometry had advanced to a considerable degree of perfection before the invention of algebra; and chemistry had made considerable progress before geology and mineralogy had become strictly sciences; while many of the facts of zoology had been arranged in systematic order more than two thou and years before the laws or methods of the stratification of the rocks, including immeasurable periods of time, had come to be accepted, as against the almost universally received doctrine of a miraculous creation of "the heavens and the earth," in six literal days about six thousand years ago.

The method of Herbert Spencer, while ostensibly based upon the distinction between the abstract and the concrete sciences, really precedes in development upon the hypothesis of Materialistic Evolution. He classifies the sciences under three tables: 1. *Abstract Science*, which includes mathematics and logic. 2. *Abstract-Concrete Science*, which includes mechanics, meteorology, chemistry, heat, light, electricity, and magnetism. 3. *Concrete Science*, which includes astronomy, astrology and geogony. Evolved from the latter are those subjects which are contained in the two following branches; 1. Mineralogy, meteorology, and geology; 2. Biology, out of which evolves morphology, physiology, psychology, and sociology. It will be seen that the distinction between the abstract and the concrete sciences has involved inconsistencies and confusion. While mathematics is appropriately placed first in the order, inasmuch as its principles apply to the measure of content, which belongs to all things susceptible of measurement, especially to the physical, mechanical and chemical departments of science; and also, as numerical mathematics applies to organic being, social statistics, etc., logic pertains to the rational nature and cannot with propriety be placed below both inorganic and organic nature without involving the necessity of separating subjects which are necessarily affiliated, as empirical psychology and rational psychology are. Further, both mathematics and logic are both abstract and concrete, being founded in principles which are applied practically both to forms and things. The term abstract, which means to draw from, or separate, or that which is considered part from its related subjects, is more appropriately applied to some other sciences than those assumed; thus *Kinematics* is an abstract science, inasmuch as it is "motion considered apart from its causes."

In the second table, the sciences of the laws relative to bodies are given before the recognition of such bodies, as if anticipating them; yet these are given under a two-fold term "abstract concrete," instead of being given as abstract. Thus, in giving the mechanical laws of solids and fluids before the supposed existence of these, is presumption, and we may well ask, how can there be laws of entities which as yet do not exist? for it should be observed, these material entities are expressed in the third table, and as being evolved from terrestrial elements, and included under the term theology. The scheme betrays the design of the classification. It seems evidently devised to exhibit, under the term "concrete," the evolution from matter and motion, of all the "totalities" included in this branch. According to this, matter and motion, in their redistribution, evolve the phenomena of force, life, and mind, while these entities, held as real by a true dualism, are regarded by Mr. Spencer as having no substantive existence, but only modes of motion manifested by matter, the only real existence, according to his philosophy. The author of this scheme proceeds upon the postulate that "The second and third groups supply the subject matter to the first, and the third supplies the subject matter to the second." Why not, then, begin with the subject matter, not simply including material phenomena, but the inherent force, and the laws of manifesting phenomena? He abhors a "serial" order, upon whatever scheme of philosophy, and combats M. Compte on this ground, yet has conveniently adopted it for his main purpose, as betrayed in his third table.

An extended criticism of his system of philosophy, and his classification of the sciences, is not intended in this paper. Such has been given by M. Lettre, Prof. Bain, and others.

Only one other scheme of classification by other persons than the writer of this, will here be given; it is that of Prof. Laurens P. Hickok, D. D., LL. D., who is the author of several profound philosophical works. He gives what he designates a "Rational Method of the Classification of all Science." His method includes two general branches or divisions: 1. Empirical or Inductive Science; 2. Rational or Transcendental Science. These fundamental divisions are clearly defined. The first is limited to *facts* or phenomena; the second to *laws* and *principles*. The first embraces "what is given in experience," using the terms empirical and inductive to include observation and experiment. It is divided into two parts: 1. *Qualities* given in Perception; 2. *Things* given in Reflection; the former grouping external phenomena, as optics, acoustics, etc., the latter grouping things in space and time, including mensuration, substance, cause, counter-cause, chemistry, magnetism, mechanism. The second or rational branch is divided into, 1. Intuitive (all mathematics); 2. Discursive (all philosophy). "Mathematics deals only in forms; philosophy deals only in existences." Discursive science is divided into two parts. 1. *Ontology*, which includes cosmology, psychology, and theology. 2. *Deontology*, defined to be the rule of speculation, includes the canons of taste, (esthetics), politics, ethics, and religion. Cosmology is treated as including not only material nature, but physiology, now classified under biology. According to this scheme, therefore, man's physical nature belongs to cosmology, the term anthropolgy not being given as it is common with systems of philosophy.

The subdivisions of Dr. Hickok do not appear to be systematically arranged. His special field of thought does not embrace the sciences pertaining to inorganic matter, nor indeed to biology, but lies in the profound depths of transcendental philosophy held to be consistent with christian theism.

PERSONAL DANGER CONNECTED WITH ELECTRIC LIGHTING.

In a recent paper Mr. Swan, of Newcastle, says:

"While on the subject of alternating currents, I take occasion to remark on a letter of Mr. Preece in the *Times*, referring to the death of two persons, said to have occurred through their taking hold of the wires in connection with an apparatus supplying the current to Jablochkoff's candle. One of these cases occurred some time ago; the other was more recent. Now, admitting for the moment that these deaths occurred directly from the shock (which I consider by no means proved), I do not think that the extreme views put forth by Mr. Preece as to the dangers consequent on electric lighting in general can be supported, and for this reason:—The machine which supplies a Jablochkoff's candle gives alternating currents; the machines which supply the ordinary electric arc, which supply my lamps, and which are more *generally* used for lighting, give a current constant in one direction. Now, although the physiological effect of the alternating currents is undoubtedly severe, yet the effect of touching the wires from a direct-current machine is merely that you feel at the moments of making and breaking contact a slight shock, but while you have hold you feel almost nothing. [Mr. Swan afterwards demonstrated practically the harmlessness of the current by taking hold of the wires from the dynamo-electric machine for some minutes.] I think Mr. Preece, knowing how many real difficulties are connected with electric lighting, should hardly have added to these by magnifying to so great an extent the dangers which in some cases *may* accompany it."

REPORT OF THE DREDGING CRUISE OF THE U. S. STEAMER *BLAKE*, COMMANDER BARTLETT, DURING THE SUMMER OF 1880.*

By Alexander Agassiz.

The cruise was undertaken with the object of determining the exact relation of the fauna of the Atlantic Ocean to that met with in the Gulf of Mexico, and in the Caribbean Sea. In the Atlantic and Pacific oceans, deep-sea soundings have generally been made to a depth of 1500 fathoms; in the Gulf of Mexico, to a depth of 450 fathoms. Work was begun in June last, south of Cape Hatteras, on a line parallel to the coast, and at an average distance of about 120 miles from it.

Instead of finding a gently sloping sea-bed, as has heretofore been supposed to exist in these latitudes, the dredgers discovered, what proved to be, a continuation of the plateau, of which the northern portion is known to extend as far as Cape St. George, and of which the southeasterly limit is supposed to rest on the Bahama Banks. The western ledge on this plateau, was examined during last summer's cruise, and proved very interesting from a geological point of view. The eastern slope has not been traced as yet. Its exact limits is a matter of conjecture, but are to be determined in next year's cruise. The sides of this plateau are steep. Three ship's lengths from a point where a depth of 100 fathoms was reached, the sounding apparatus did not strike bottom until 450 fathoms of the line had been paid out. More animal life is found on the edge of the plateau than elsewhere. The character of the animals is, on the whole, the same as that of the species found in the Gulf of Mexico and the Caribbean Sea. The edges are composed of rich deposits of alluvia and mud, washed from the top of the plateau by the action of the Gulf stream, the course of which extends over the entire length of this Atlantic plateau. The deposits of numerous rivers flowing into the Atlantic Ocean serve to enrich the western slope. These conditions are all favorable to the preservation of animal life on the edges of this submarine highland, while on its top no animal life is to be met with, a certain species of coral formation excepted. Altogether the success, obtained by this expedition, was great. The same set of officers has served for three consecutive seasons. The same amount of work, which, in the course of the first year's cruise, required three months' time, during the past season has been accomplished in seven weeks. Work was continued day and night. The rapidity with which the soundings were made enabled eight dredges, each of them to the depth of 800 fathoms, to be made every twenty-four hours. Formerly, one deep-sea sounding was considered a good day's work.

* Read before the National Academy of Sciences, N. Y., 1880.

THE DURATION OF THE ARCTIC WINTER.*

By Leutenant F. Schwatka, U. S. N.

The generally received opinion, that the Arctic winter, especially in the higher latitudes, is a long dreary one of perfectly opaque darkness, is not strictly correct. In latitude 83° 20′ 20″ N., the highest point ever reached by man, there are four hours and forty-two minutes of twilight on December 22, the shortest day in the year, in the Northern Hemisphere. In latitude 82° 27′ N., the highest point where white men have wintered, there are six hours and two minutes in the shortest day, and it is in latitude 84° 32′ N., 172 geographical miles nearer the North Pole than Markham reached, and 328 geographical miles from that point, that the true Plutonic zone, or that one in which there is no twilight whatsoever, even upon the shortest day of the year, must be found. Of course, about the beginning and ending of this twilight, it is very feeble and easily extinguished by even the slighest mists, but nevertheless it exists, and is quite appreciable, on clear cold days, or nights, properly speaking. The North Pole itself is only shrouded in perfect blackness from November 13 to January 29, a period of seventy-seven days. Supposing that the sun has set (granted, the existence of a circum-polar sea, or body of water, unlimited to vision) on September 24, not to rise until March 18, for that particular point, giving a period of about fifty days of uniformily varying twilight, the Pole has about 188 days of continuous daylight, 100 days of varying twilight, and 77 of perfect inky darkness (save when the moon has a Northern declination) in the period of a typical year. During the period of a little over four days, the sun shines continuously on both the North and South Poles at the same time, owing to refraction parallax, semi-diameter and dip of the horizon.

SIGSBEE'S GRAVITATING TRAP*

By Alexander Agassiz.

Lieutenant-Commander Sigsbee devised this trap to ascertain the depth to which the animal fauna of the ocean descends. The extisence of animal life at great depths is extremely doubtful and this belief is confirmed by the fact that, whether dredging in 50 or 2000 fathoms of water, there is always brought to the surface the same species of animals. To secure water from different depths, Lieutenant-Commander Sigsbee constructed cylinders with traps, which could be opened from on board the vessel by lines, and which closed with the pressure of the surrounding water as soon as filled. They were found to sink 50 fathoms in 45 seconds. At the depth of 50 fathoms the trap brought to the surface the animals that usually float on the surface. At the depth of from 50 to 100 fathoms the number of animals decreased and only five species of pelagic forms were found, while seventeen species had been discovered at the former depth. Using every possible precaution the apparatus was next sunk in from 100 to 150 fathoms of water, but no animal life was found. The water was perfectly clear. The dead bodies of pelagi require from three to four days to sink in 1000 fathoms of water.

* Read before the National Academy of Sciences, N. Y., 1880.

DR. SIEMENS' ELECTRICAL FURNACE.

At a meeting of the Society of Telegraphic Engineers, Dr. Siemens gave the following description of his electrical furnace :

Amongst the means at our disposal for effecting the fusion of highly refractory metals, and other substances, none has been more fully recognized than the oxy-hydrogen blast. The ingenious modification of the same by M. H. Ste.-Claire Deville, known as the Deville furnace, has been developed and applied for the fusion of platinum in considerable quantities by Mr. George Matthey, F. R. S.

The Regenerative Gas Furnace furnishes, however, another means of attaining extremely high degrees of heat, and this furnace is now largely used in the arts—among other purposes, for the production of mild steel. By the application of the open hearth process, 10 to 15 tons of malleable iron, containing only traces of carbon or other substances alloyed with it, may be seen in a perfectly fluid condition upon the open hearth of the furnace, at a temperature probably not inferior to the melting-point of platinum. It may be here remarked that the only building material capable of resisting such heats is a brick composed of 98.5 per cent. of silica, and only 1.5 per cent. of alumina, iron, and lime, to bind the silica together.

In the Deville furnace an extreme degree of heat is attained by the union of pure oxygen with a rich gaseous fuel under the influence of a blast, whereas in the Siemens furnace it is due to slow combustion of a poor gas, potentiated, so to speak, by a process of accumulation through heat stores or regenerators.

The temperature attainable in both furnaces is limited by the point of complete dissociation of carbonic acid and aqueous vapor, which, according to Ste.-Claire Deville and Bunsen, may be estimated at from 2500° to 2800° C. But long before this extreme point has been reached, combustion becomes so sluggish that the losses of heat by radiation balance the production by combustion, and thus prevent further increase of temperature.

It is to the electric arc, therefore, that we must look for the attainment of a temperature exceeding the point of dissociation of products of combustion, and indeed evidence is not wanting to prove the early application of the electric arc to produce effects due to extreme elevation of temperature. As early as the year 1807, Sir Humphrey Davy succeeded in decomposing potash by means of an electric current from a Wollaston battery of 400 elements; and in 1810 the same philosopher surprised the members of the Royal Institution by the brilliancy of the electric arc produced between carbon points through the same agency.

Magneto-electric and dynamo-electric currents enable us to produce the electric arc more readily and economically than was the case at the time of Sir Humphrey Davy, and this comparatively new method has been taken advantage of by Messrs. Huggins, Lockyer and other physicists, to advance astronomical and chemical research with the aid of spectrum analysis. Professor Dewar, quite recently, in experimenting with the dynamo-electric current, has shown that in his lime tube or crucible several of the metals assume the gaseous condition, as demonstrated by the reversal of the lines in his spectrum, thus proving that the temperature attained was not much inferior to that of the sun.

My present object is to show that the electric arc is not only capable of producing a very high temperature within a focus or extremely contracted space, but also such large effects, with comparatively moderate expenditure of energy, as will render it useful in the arts for fusing platinum, iridium, steel or iron, or for affecting such reactions or decompositions as require for their accomplishment an intense degree of heat, coupled with freedom from such disturbing influences as are inseparable from a furnace worked by the combustion of carbonaceous material.

The apparatus which I employ consists of an ordinary crucible of plumbago or other highly refractory material, placed in a metallic jacket or outer casing, the intervening space being filled up with pounded charcoal or other bad conductor of heat. A hole is pierced through the bottom of the crucible for the admission of a rod of iron, platinum or dense carbon, such as is used in electric illumination. The cover of the crucible is also pierced for the reception of the negative electrode, by preference a cylinder of compressed carbon of comparatively large dimensions. At one end of a beam supported at its centre is suspended the negative electrode by means of a strip of copper, or other good conductor of electricity, the other end of the beam being attached to a hollow cylinder of soft iron free to move vertically within a solenoid coil of wire, presenting a total resistance of about 50 units or ohms. By means of a sliding weight, the preponderance of the beam in the direction of the solenoid can be varied so as to balance the magnetic force with which the hollow iron cylinderis drawn into the coil. One end of the solenoid coil is connected with the positive, and the other with the negative pole of the electric arc, and, being a coil of high resistance, its attractive force on the iron cylinder is proportional to the electromotive force betweeen the two electrodes, or, in other words, to the electrical resistance of the arc itself.

The resistance of the arc was determined and fixed at will within the limits of the source of power, by sliding the weight upon the beam. If the resistance of the arc should increase from any cause, the current passing through the solenoid would gain in strength, and the magnetic force, overcoming the counteracting weight would cause the negative electrode to descend deeper into the crucible; whereas, if the resistance of the arc should fall below the desired limit, the weight would drive back the iron cylinder within the coils, and the length of the arc would increase, until the balance between the forces engaged had been re-established.

The automatic adjustment of the arc is of great importance to the attainment of advantageous results in the process of electric fusion; without it the resistance of the arc would rapidly diminish with increase of temperature of the heated atmosphere within the crucible, and heat would be developed in the dynamo-electric machine to the prejudice of the electric furnace. The sudden sinking or change in electrical resistance of the material undergoing fusion would, on the other hand, cause sudden increase in the resistance of the arc, with a likelihood of its extinction, if such self-adjusting action did not take place.

Another important element of success in electric fusion consists in constituting the material to be fused the positive pole of the electric arc. It is well known that it is at the positive pole that the heat is principally developed, and fusion of the material constituting the positive pole takes place even before the crucible itself is heated up to the same degree. This principle of action is of course applicable only to the melting of metals and other electrical conductors, such as metallic oxides, which constitute the materials generally operated upon in metallurgical processes. In operating upon non-conductive earth or upon gases, it becomes necessary to provide a non-destructible positive pole, such as platinum or iridium, which may, however, undergo fusion, and form a little pool at the bottom of the crucible.

In this electrical furnace some time, of course, is occupied to bring the temperature of the crucible itself up to a considerable degree, but it is surprising how rapidly an accumulation of heat takes place. In working with

the modified medium-sized dynamo-machine, capable of producing 36 webers of current with an expenditure of 4 horse-power, and which, if used for illuminating purposes, produces a light equal to 6000 candles, I find that a crucible of about 20 centimetres in depth, immersed in a non-conductive material, is raised up to white heat in less than a quarter of an hour, and the fusion of one kilometre of steel is effected within, say, another quarter of an hour, successive fusions being made in somewhat diminishing intervals of time. It is quite feasible to carry on this process upon a still larger scale by increasing the power of the dynamo-elec ric machine and the size of the crucibles.

By the use of a pole of dense carbon, the otherwise purely chemical reaction intended to be carried into effect may be interfered with through the detachment of particles of carbon from the same; and although the consumption of the negative pole in a neutral atmosphere is exceedingly slow, it may become necessary to substitute for the same a negative pole so constituted as not to yield any substance to the arc. I have used for this purpose (as also in the construction of electric lamps) a water pole or tube of copper, through which a cooling current of water is made to circulate. It consists simply of a stout copper cylinder closed at the lower end, having an inner tube penetrating to near the bottom for the passage of a current of water into the cylinder, which water enters and is discharged by means of flexible india-rubber tubing. This tubing being of non-conductive material, and of small sectional area, the escape of current from the pole to the reservoir is so slight that it may be entirely neglected. On the other hand, some loss of heat is incurred through conduction in the use of the water pole, but this loss diminishes with the increasing heat of the furnace, inasmuch as the arc becomes longer, and the pole is retired more and more into the crucible cover.

To melt a gram of steel in the electric furnace takes, it is calculated, 8100 heat units, which is within a fraction the heat actually contained in a gram of pure carbon. It results from this calculation that, through the use of the dynamo-electric machine, worked by a steam engine, when considered theoretically, 1 lb. of coal is capable of melting nearly 1 lb. of mild steel. To melt a ton of steel in crucibles in the ordinary air furnace used at Sheffield, from 2½ to 3 tons of best Durham coke are consumed; the same effect is produced with 1 ton of coal when the crucibles are heated in the Regenerative Gas Furnace, whilst to produce mild steel in large masses on the open hearth of this furnace, 12 cwts. of coal suffice to produce 1 ton of steel. The electric furnace may be therefore considered as being more economical than the ordinary air furnace, and would, barring some incidental losses not included in the calculation, be as regards economy of fuel nearly equal to the Regenerative Gas Furnace.

It has, however, the following advantages in its favor: 1st. That the degree of temperature attainable is theoretically unlimited. 2d. That fusion is effected in a perfectly neutral atmosphere. 3d. That the operation can be carried on in a laboratory without much preparation, and under the eye of the operator. 4th. That the limit of heat practically attainable with the use of ordinary refractory materials is very high, because in the electric furnace the fusing material is at a higher temperature than the crucible, whereas in ordinary fusion the temperature of the crucible exceeds that of the material fused within it.

Without wishing to pretend that the electric furnace here represented is in a condition to supersede other furnaces for ordinary purposes, the advantages above indicated will make it a useful agent, I believe, for carrying on chemical reactions of various kinds at temperatures and under conditions which it has hitherto been impossible to secure.

DESILVERIZATION OF LEAD BY THE ZINC PROCESS.*

By J. E. Stoddart.

The treatment of argentiferous leads with zinc, for the purpose of extracting the silver and refining the lead, is by no means a novel process. About twenty years ago a metallurgist named Parks took out patents for desilverizing rich leads by means of zinc, and a manufacturing firm adopted his process. They were, however, subsequently obliged to abandon it, in consequence of the difficulty experienced in the separation of the zinc from the concentrated silver, to admit of the cupellation of the latter metal. A German chemist named Flach afterwards took up the subject, and by running the alloy of zinc, silver, and lead along with iron slag, through a peculiarly constructed blast-furnace, was enabled to free the concentrated silver-lead from zinc. He also proposed the use of this furnace for removing of traces of zinc from the desilverized lead, but this was abandoned in favor of the ordinary improving or calcining pan. The operation with the blast-furnace was found to be very troublesome, and as the greater portion of the zinc was entirely lost, was by no means economical. M. Manes, of Messrs. Guillem & Co., Marseilles, who were the first to work Flach's process, found out and patented a simple means of treating the alloy, and recovering the zinc by distillation. This is the process now in use and known as the Flach-Guillem process, and which is carried on in the following manner:—About 18 tons of "rich lead," containing generally from 60 to 70 ounces of silver per ton, are melted in a large cast-iron pot, to which 1 per cent. by weight of zinc is added, and the whole well stirred for twenty minutes. The fires are drawn, and the contents allowed to settle and cool until the zinc rises to the surface, and forms a solid ring or crust containing the silver and other foreign metals. This alloy is removed to a small pot at hand, where part of the lead is sweated out, and the alloy thoroughly dried. The large pot with the lead now partially desilverized is again heated up, and treated in the same way as before, but with the addition of only a half per cent. of zinc, which when it has risen to the top is removed as before, and dried. A third addition of a quarter of per cent. of zinc is found necessary to take out the remainder of the silver, care being taken, on the cooling of this zincing, that all the crystals are cleanly skimmed off. The lead in the large pot is assayed, and found almost always to contain less than 5 dwts. of silver to the ton of lead; if it should happen to contain more, it is due to carelessness on the part of the workmen. The pot is now tapped, and the lead run down into an improving pan, where it is kept at a high heat for nearly eight hours, for the purpose of oxidising or burning off the small percentage of zinc which is left in it from the zincing process; after seven or eight hours' firing in this pan it should contain no trace of zinc. It is then tapped and run into moulds for market lead, or for the manufacture of lead products. The old improving pans were made of cast-iron, placed on a bed of sand, with a groove in the upper sides, which groove was filled with bone-ash to prevent the action of oxide of lead on the iron. These pans, from the giving way of the bone-ash, and the great wear and tear on the iron from the high heats necessary, were found to be both troublesome and expensive; they were very often under repair, and seldom lasted more than six or eight months. They have been superseded by an improving pan of cast-iron lined with brick inside. This pan, instead of being placed on a bed of sand, as was the case with the old improving pan, is hung on brick walls, and is quite open both below and round the outside. This new pan has been working in the patentee's works, Marseilles, for some years without any break down. It burns no more coal, and can be as economically worked in every way as the old pans. The zinc and silver alloy, after being dried, is melted in a plumbago crucible, covered on the top, well luted with fire clay, connected with a small cast iron receiver by means of a plumbago pipe, and fired up with coke. The zinc, distils over, and is condensed in the iron receiver. After all the zinc has been distilled, the pipe is disconnected, the cover removed, and the lead and silver, left in

* Read before the Philosophical Society of Glasgow, Nov. 8, 1880.

the crucible, is ladled out into moulds. Thence it is taken to the refinery, where it is cuppelled in the usual way. The block of metallic zinc recovered in the condenser is removed, and used over again in the first part of the process. All the oxide of lead and dross formed in the different processes are taken to the reducing-furnace, mixed with coal-dross, and reduced to the metallic state. The refuse from this furnace still contains some lead, and is put through the slag hearth, a blast furnace fired with coke, the fumes of lead oxides from which are condensed in what is known as Johnson's patent condenser, and are all recovered. The lead from the slag hearth, containing a number of impurities, as copper, antimony, iron, or sulphur, is taken to the improving furnace—a furnace built in exactly the same way as the dezincifying pan. About 20 tons of this lead are heated for a period generally from four or five days, but the time varies according to the amount of impurities present. The oxidised impurities, as they are formed, float to the surface, and are skimmed off by the workman, who is made to keep the lead perfectly clean, so as to have a fresh surface always exposed to the action of the flame. The dross skimmed off is first of a black color, but gradually becomes lighter as the operation goes on, until it shows nothing but yellow oxide of lead. When this appearance is noted the pan is tapped into moulds, or into the desilverizing pot, where it is treated with zinc, and the silver extracted as in the manner before described. By this process the lead can be desilverized and turned out in the shape of market lead in thirty hours from the time it is put in process; the loss in working being not more than 1¼ per cent., and the amount of oxide of lead formed is very much less than that formed in any of the other processes, thereby effecting a very considerable saving in the working expenses. It makes an excellent quality of sheets, pipes, red-lead, and litharge, and has even been used for the manufacture of white-lead. There is, however, one product it cannot be used for by itself, and that is the manufacture of chemical lead. Your President gave us a very interesting paper on this subject last session, showing that the reason of its not being suitable for this was on account of its extreme purity. I understand that Mr. James Napier, Jr., of this Society, has made a number of experiments in the same direction, and found that by adding to it a small percentage of copper or antimony, or both, a good chemical lead can be obtained. That all the silver is thoroughly taken out may be seen from the fact that there is an excess of silver obtained on the large scale to the extent of nearly 2 per cent. over the assays. An analysis of the market lead gave—Antimony, 0.0015, and silver 0.0004 per cent., a trace of copper, but no iron or zinc; from which it will be seen that the lead refined by the zinc process is almost chemically pure, and to this is due the finer quality of the products manufactured from it.

THE TERRESTRIAL PROGRESSION OF THE BRAZILIAN "CAMBOTA," *CALLICHTHYS ASPER.*

To the Editor of SCIENCE :—

Letters from Mr. John C. Branner, who was engaged upon the geological survey of Brazil under the late Prof. C. F. Hartt of Cornell University, contain extracts from letters to him from Mr. Joseph Mawson, Bahia, describing some habits of the siluroid fish, *Callichthys Asper*, there known as "*Cambota*." These habits have probably been observed and described already, but as they are not referred to in Günther's Catalogue of the Fishes in the British Museum the account of a recent observer may be interesting to the readers of "SCIENCE."

"During the rainy season the fish live in fresh water pools. When the pools dry up in the dry season, they bury themselves in the mud and remain there until the rains return the following year. They are noted for overland excursions. It is said that they are often met with going from one pool to another.

I have had six of the fish in a narrow-necked tin of water, with some sand and mandioca meal at the bottom, for five days, and they continue active and vigorous, especially the smaller ones. These examples measure from 5 to 10 cm. in length, and I have seen them much larger. I have had them out in the garden several times. I find that they move best on smooth damp ground, and are embarrased by sticks or other inequalities. They can jump a little vertically, but their progress on land is effected entirely by a quick wriggling motion of the body which is nearly flat upon the ground. The paired fins (pectorals and ventrals) are extended laterally, and seem to bear little if any weight; but they move slightly, and appear to serve to steady the body.

Last night I heard a peculiar sound, and on looking around I saw one of the fish travelling about the room. He had escaped from the tin which was in my bed-room, had fallen from the table to the floor, and travelled along the corridor, about 12 meters (about 40 feet) to the *sala*. I watched him travelling for two hours, during which time I estimate that he moved at least 90 meters. Toward the end of the two hours he seemed to flag a little, but in the earlier part his method and speed were fairly seen. He seemed to start with a sudden movement of the head or the barbels, then wriggled briskly for 5 to 10 seconds, advancing about a meter. Then he would rest for about 10 seconds, and start as before. This was kept up during the whole two hours, and I left him still moving. This morning, five hours later, I found him dead. While he was moving I spilled some water on the floor, but he crossed it; hence I concluded that it was mud rather than water of which he was in search. The fish are eaten and considered good food."

It may be added that some examples of these fish were brought me by Mr. Branner, and found to be the *Callichthys asper*. The species of the genus are easily recognized from the fact that the trunk is covered by only two rows of large scales, a dorsal and a ventral series.

The ability of *Callichthys* to withstand a somewhat protracted deprivation of water, which it shares with other fishes of South America and India, with the North American Ganoids *Amia* and *Lepidosteus*, and with some other Ganoids and Dipnoans, is probably accounted for by the observations of Prof. Jobert of Rio Janeiro, published in the *Annales des Sciences Naturelles*, sixth series, V. and VII.

ITHACA, Dec. 21, 1880. BURT G. WILDER.

ASTRONOMY.

A PROBABLE VARIABLE STAR.—On Nov. 25, Swift's Comet was compared with the star No. 4339 of Lalande, by Mr. Talmage at Mr. Barclay's Observatory, Leyton, the magnitude of the star being estimated 8, as it was also by Lalande. Argelander in the *Durchmusterung* gives it 6.4 and Heis made it a naked eye star 6.7, but erroneously identifies it with Lalande 4359. It escaped observation in the Bonn Zones and may be worth occasional examination as likely to prove an addition to our variable star list.—*Nature.*

WINNECKE suggests that Hartwig's Comet is identical with the comets of 1382, 1444, 1506, 1569 and that it therefore has a period of 62⅓ years.

THE asteroid picked up by Peters on Oct. 10, is identical with that discovered by Palisa on Sept. 30.

M. TRIPIER is expected to take charge of the Observatory of Algiers in April, 1881.

DR. COPELAND at Dunecht, using Prof. Pickering's device of a prism introduced between the eyepiece and

objective of his telescope, discovered a small binuclear, planetary nebula. Its position for 1880 is R. A. 21h. 2m. 11.8s, Dec. 47° 22.2′ N.

Washington, December 23, 1880. W. C. W.

SWIFT'S COMET.

The following are two more positions of this comet. These were obtained by the aid of a ring micrometer. Nov. 20, 1880, R. A. 1h. 6m. 24s.: Dec. +54° 22′ 39″: Time is 10h. 49.1m. Washington *m. t.* Dec. 5, 1880, R. A. 4h. 7m. 49.2s.: Dec.+48° 30′ 10″ Time is 9h. 49m. Washington *m. t.* I have also an observation of position for Nov. 7, which has not been reduced as I have not yet managed to find the position of a fifth magnitude star, to which the comet's position was referred. The star's position will soon be obtained.

Nashville, Tenn., Dec. 21, 1880. E. E. BARNARD.

NEW COMPANION TO γ FORNACIS.

Sir John Herschel entered this as No. 2161, of his Fifth Catalogue of Double Stars, by reason of a distant eleventh magnitude which he detected, at an estimated distance of 45″, in the direction of 169.4°. This star was measured by me in 1879 in connection with a series of observations of a class of stars given in "Smyth's Bedford Catalogue." Since then, in repeating the measure of the Herschel Star, I have discovered a much nearer component, which fairly entitles the large star to be classed as double. The new star is very faint, and a rather difficult object with the 18½-inch refractor of the Dearborn Observatory. This, however, is partly due to its low altitude in this latitude, it being 25° south of the Equator. The mean result of my measures of these companions on four nights is:—

A and B	P=144.4°	D=11.53″	1880.93
A and C	157.0°	48.85″	1880.68

I have estimated the new companion as thirteenth magnitude. This, it will be remembered, is in the Struve scale of magnitudes, which would make it very much smaller than Herschel's twentieth magnitude.

The place of the principal star for 1880 is:—

R A. 2h. 44m. 33s.
Decl. —25° 3″

S. W. BURNHAM.

CHICAGO, Ills., December 21, 1880.

To the Editor of SCIENCE:

Professor Winchell, in the last number of "SCIENCE," refers to what he supposes "to be some errors in the dates in the list of minor planets discovered by the late Professor Watson," viz.:

(133) Cyrene, discovered Aug. 14, 1873, *Am. Jour. Sci.* III., VI., 296.
(174) Phaedra, " " 8, 1877, " " " III., XIV., 325.
(175) Andromache, " Sept. 2, 1877, " " " III., XIV., 325.

In correcting these supposed errors Prof. Winchell has fallen into more grievous ones.

Owing to a misprint in the *Astronomische Nachrichten* I was led to record the date of the discovery of (133) as August 26; it should be August 16, vid. *Astron. Nach.* 82,241 *Am. Jour. Sci.* III., VI., 296.

(174) Phaedra was discovered September 2, 1877, vid. *Am. Jour. Sci.* III., XIV., 325. This date is given September 3 in *Circ. Berl. Jahr.* No. 76. September 2 is undoubtedly the correct date. The object discovered August 8 turned out to be (141) Lumen, vid. III., XIV., 429, *Circ. Berl. Jahr.* No. 76.

(175) Andromache was discovered October 1, 1877, vid. *Astron. Nach.* 91-127; also *Circ. Berl. Jahr.* No. 81. The object called (175) in *Am. Jour. Sci.* III., XIV., 325 was really (174) Phaedra, as is explained in *Circ. Berl. Jahr.* No. 81. AARON N. SKINNER.

U. S. NAVAL OBSERVATORY,
WASHINGTON, D. C., Dec. 22, 1880.

BOTANY.

PILOSITY AS A TERATOLOGICAL PHENOMENON.—Hitherto teratologists have considered undue pilosity, or the adventitous production of hair in plants, as a matter of minor importance, but M. Ed. Heckel, in a recent note to the French Academy, (*Comptes Rendus*, xci., p. 349), insists that there are certain phases of this sort of change in plants which have a higher significance than that of a simple variation. He proposes to divide the phenomenon into the following three categories:

(1.) *Physiological Pilosity*, which includes the formation of hairs, or the increase in number of these, on the parts of plants where they are normally present, or even entirely wanting. Such cases are oftenest seen when plants change their habitat from a wet to a dry soil. This sort of physiological adaptation takes place within quite narrow limits; and it varies from glabrousness to pilosity unaccompanied by any alteration of specific characters.

(2.) *Teratological Pilosity*, which begins at the moment the specific habit is altered, and acquires its maximum when the modifications are profound enough to suggest the idea of a new species. A large number of conditions capable of producing nutritive troubles in plants may give rise to this peculiar phenomenon, which M. Heckel proposes to introduce into teratological literature under the distinctive term of "Deforming Pilosity" (*Pilosisme deformant*).

(3.) *Pilosity due to the Sting of Insects or to Organic Variations*, which is clearly distinguished from the former in being very localized (e. g. certain galls, the filaments of *Verbascum* with aborted anthers, etc.,) and which cannot change the habit of the species.

Of changes due to *deforming pilosity*, M. Heckel gives two prominent examples which he has studied, *Lilium Martagon*, L., and *Genista aspalathoides*, Lam. The alterations in the last named plant are so profound that its monstrous state has even been described by De Candolle as a species, under the name of *G. Lobelii;* while by Morris it has been regarded as a marked variety, and named by him var. *confertior.*

MICROSCOPY.

The remarks of the "Fellow of the Royal Microscopical Society," who so ably advises *The English Mechanic* on Microscopy, on the faulty construction of many forms of "Student's" microscopes, is well timed.

In regard to the system of getting as much as possible for the money, he says: "It is just this petty economy in the original outlay on a practical stand that cramps the student when he has acquired some manipulative dexterity. Dealers and manufacturers are, of course, driven to supply what is recommended by the 'authorities.' The continued refrain of 'cheapness, cheapness,' brings down the construction of the microscope until it has become (in far too many instances) the baldest tube, stage, mirror, objective, and eyepiece with which it is possible to view a speck of saliva on a slip of glass. This perpetual reduction of the finish and design of the microscope tends to exclude all the better opticians from supplying students' microscopes, for they cannot do justice to themselves when the price is to be cut down as it has been during the last few years. The consequence is that an enormous number of common French or German instruments has been imported into this country and America; students have been 'set up' with these things, to discover later on, when they have become experienced enough to judge of such matters, that they have no market value except as lumber.

The severe competition, lately, has been mainly confined to the production of *low-priced* microscopes, *not* the production of an *efficient* instrument at a moderate cost; the consequence appears to have been that manufacturers whose appliances are about equal to the task of making gas-fittings have been induced to enter the competition; a model of stand has been placed before them which they have copied 'more or less;' at any rate, the

market has been glutted with what appears to be lacquered brass-work."

This is well expressed, and needs but one word in addition, as to the remedy: On this point we advise the microscopist to recur to the good, but old-fashioned plan, of gradually building up his microscope and its accessories. Let his money accumulate until he can purchase a first-class stand of a reliable maker, the adjustments of which will be reliable, and arranged to receive all necessary accessories as they are added. With such a base of operation, he will have nothing to retract, and every step will be one of progress.

In justice to some makers in America, it must be admitted that they have produced, recently, some moderately-priced instruments which are well finished; but there are also some students' microscopes, on the market, carelessly made, badly constructed, and unfit for scientific work.

As to objectives the writer in the *Eng. Mech.*, above referred to, says: "Large firms abroad, who are not opticians at all, and whose appliances are suited to the production of bull's-eye lenses, &c., have been induced to 'take up' with the microscope, and thus thousands of things called objectives have been floated that are a disgrace to microscopy. Here and there an advertiser of microscopes obtains these things, patches on some trumpery adapter that conceals the original make, and disposes of the wares as 'our own first-class manufacture;' the unwary student finds out how he has been imposed upon only when experience has taught him the meaning of good optical appliances, among which those he is unhappily possessed of take no rank whatever."

We have no doubt the writer has good reason for making this exposure of the tricks of opticians. The practice of importing objectives and, after remounting, passing them off as "*our own first-class manufacture,*" is not confined to Europe. When in London, on one occasion, we were shown a written order from a well-known American objective maker, for a quantity of objectives, to be used for this very purpose.

It is certainly a disgraceful state of things that a microscopist, who purchases an objective of a reputable maker, should receive a glass manufactured by an inferior house, whose prices are probably 50 per cent less.

Purchasers of microscopes and objectives in the United States, who endeavor to steer a course between exorbitant charges and inferior workmanship, have need of much caution, and if inexperienced, should not rely on their own judgment.

The number of microscopists in this country appears to be on the increase if we may draw conclusions from the statement of a maker, who asserts that he has orders in hand which will keep him employed for four months.

PHYSIOLOGY.

Mr. Simon H. Gage has just been appointed Assistant Professor of Physiology, and Lecturer on Microscopical Technology in Cornell University. While a student in the Natural History course at that institution, Mr. Gage acted as laboratory assistant, and since his graduation, in 1877, has been Instructor in Microscopy and Practical Physiology. He has published several papers, mostly microscopical, some of which have been copied into European Journals. In addition to the supervision of other laboratory work, Mr. Gage gives practical lectures upon Microscopical Technology, in all its branches, and upon Microscopy in relation to Medical Jurisprudence. His deserved appointment will not only strengthen the general Natural History instruction, but greatly aid Professor Wilder's efforts to provide preliminary medical education.

The following list of the published papers of Mr. Gage will give some idea of his scientific activity, and indicate his special line of research:

1. Plaster of Paris as an Injecting Mass.—*American Naturalist*, November, 1878, pp. 717–724.
2. Notes on the Cayuga Lake Star Gazer.—*Cornell Review*, November, 1878, pp. 91–94.
3. The Ampulla of Vater and the Pancreatic Ducts in the Domestic Cat, Felis Domestica.—*The American Quarterly Microscopical Journal*, January, 1879. pp. 123–131, and April, 169–180.
4. Laboratory Notes in Microscopy.—*Am. Q. M. Jour.* Vol. I., pp. 71, 160, 166. Part of these were copied in the *Journal of the Royal Microscopical Society*, of London, 1879, p. 191. and also in the *American Journal of Microscopy and Popular Science*, 1879, p. 176.
5. The Inter-Articular Ligament of the Head of the Ribs in the Cat.—*Proc. of the Am. Association for the Advancement of Science*, Saratoga Meeting, 1879, pp. 421–424.
6. A New Method of Demonstrating the Thoracic Duct in Animals.—*Proc. A. A. A. S.*, 1879, p. 425.
7. An Apparatus for Photographing Natural History Objects in a Horizontal Position. Read before the A. A. A. S., at Saratoga, and published by title in the proceedings for 1879, p. 489.
8. Preparation of Ranvier's Picro-Carmine.—*American Monthly Microscopical Journal*, 1880, pp. 22–23. Copied in the *Jour. of the Royal Mic. Soc. of London*, 1880. pp. 501–502.
9. Permanent Microscopical Preparations of Amphibian Blood. Read at the Boston Meeting of the A. A. A. S., and published in the *American Naturalist*, October, 1880, pp. 752–753.
10. Permanent Microscopical Preparations of Plasmodium. Read at the Boston Meeting of the A. A. A. S., and published in the *Am. M. Mic. Jour.*, October, 1880, pp. 173–174.
11. A supplement to the article on calcareous crystals in Amphibia, by Professor Bolton, of Trinity College. This supplement was prepared at his request, and published with his paper in the *Proc. of the A. A. A. S.*, 1879, p. 418.

Finally Dr. Wilder and Mr. Gage have been preparing a laboratory manual for the last two years, which will be published next fall.

For an opinion as to the value of the laboratory notes, etc., mentioned above, see the Proceedings of the New York Microscopical Society, as published in the *Am. Jour. of Mic. and Pop. Science*, Feb., 1880, p. 51.

CHEMICAL NOTES.

ULMIC MATERIALS PRODUCED BY THE ACTION OF ACIDS UPON SUGAR.—The formulæ ascribed by Mulder to the ulmic products which had been dried at from 140° to 165° before being submitted to combustion are not a dmissible, since, at temperatures above 100°, these bodies lose a notable quantity of volatile matter, and in particular of formic acid. The ulmic substances obtained by the action of dilute sulphuric acid upon sugar, and which may be called sacchulmine, appear in the form of minute yellowish brown globules. On treatment with a cold aqueous solution of caustic potassa, sacchulmine gives off an acid principle derived from the action of sulphuric acid upon glucose. The ulmic matter (sacchulmine), insoluble in cold alkaline liquids, is derived directly from saccharose. In the ulmification of sugar there is evolved a considerable quantity of volatile acids, especially formic acid.—F. SESTINI.—*Gazzetta Chimica Italiana.*

THE DIFFUSION AND THE PHYSIOLOGICAL CONDITION OF COPPER IN THE ANIMAL ORGANISM.—Prof Giovanni Bizio has attempted to prove that his father, Bartolomeo Bizio, was the original discoverer of the normal occurrence of copper in the animal economy.

CHEMICAL CONSTITUTION OF MILK.—Caseine is not a homogeneous albuminoid, but a mixture of albumen and protalb-bodies which appear as transition stages in peptonisation. In the milk globules has been found an albumenoid which constitutes the serum. In the curd are met with an albuminous body identical with the stromæi alb-compound of the globules, a body which Danilewsky and Radenhausen name orroproteine and two series of peptones. Hence it is no longer proper, in milk-analysis, to speak of caseine and albumen, but rather of albuminates.—DR. N. GERBER.—*Correspondenz-Blatt.*

OCCURANCE OF COPPER.—Dr. W. Hadelich has detected and determined copper in the soil of a churchyard, and in portions of exhumed bodies.

SIMPLE METHOD OF OBSERVING THE PHENOMENA OF DIFFRACTION.—The rays reflected by a heliostat are concentrated by two lenses. In the focus is placed a diaphragm with a very small aperture, and the luminous glass is received on a screen. In this glass are placed the bodies whose shadows are to be studied.—V. D. Vorak.

BOOKS RECEIVED.

FOUR LECTURES ON STATIC ELECTRIC INDUCTION, by J. E. H. Gordon, B. A., Assistant Secretary of the British Association—16mo, price 80 cents. D. Van Nostrand, New York, 1881.

These lectures, which were delivered before the Royal Institution of Great Britain during the early part of 1879, convey, in simple and clear language, an explanation of the laws of the induction of electricity, pointing out the problems connected with it, which have been solved, and what remains to be done in this direction.

About forty illustrations take the place of the lecturer's apparatus, and will be found a great aid to the reader in following the text. As a popular guide to a subject of great present interest, this little work, from so reliable a source, should be welcome. As the author admits, our knowledge of electricity is very incomplete; the question, What is electricity? still remains unsolved. Of the phenomena considered in these lectures, a few only can be explained, the experimental facts standing out alone and disjointed.

Many lines of reasoning and research open out a little way and then are lost in the darkness through which, as yet, human sight cannot pierce.

The magnitude of the experiments and the exhaustive researches of Edison are making these difficult ways clear and trodden paths, utilizing the disjointed facts and weaving them into one perfect and harmonious whole.

NATUREN.—Et illustreret maanedsskrift for populær Naturvidenskab, udgivet af Hans H. Reusch, cand. real.—Assistent ved den geologiske Undersögelse—Kristiania—Trykt hos A. W. Brögger. Vol. I, No. 2, 1880.

The gratification which attends success, must, in the case of the Editors of *Nature*, have been increased by finding that their journal has become the model for scientific weekly journals in other countries.

France, Germany and Italy have each their *Nature* published in their respective languages, and we have now to congratulate Norway on possessing an excellent scientific journal on the some model.

The cultivation of science in Norway is of recent date, the first efforts in this direction being contemporaneous with the foundation of the present constitutional monarchy in the year 1814, when the separation from Denmark took place. About this time also the first Norwegian University was organized.

The short time the constitution of Norway has existed appears sufficient to prove that political freedom and independence—if not absolute conditions—are at least powerful vehicles for the intellectual development of an energetic people.

As might be expected the strong and impulsive enthusiasm which arose from this political regeneration was not at first concentrated on the solution of scientific subjects, but the intellectual life thus created found expression in a more æsthetic tendency, and poets who then and later arose are remembered and appreciated, while the Norwegians still treasure the names of Welhaven, Wergeland, Björnson and Ibsen.

Of those Norwegians who have established a reputation in the field of science may be mentioned Professor Christopher Hansteen, known by his researches in Magnetism, and as an eminent mathematician. He died in 1873, and may be said to have been succeeded by Professors O. J. Broch, Sofus Lie and Bjerknaes.

Professor Michael Sars has done excellent work on the lower fauna of the country, and his son, Professor G. O. Sars, has written several important works on the subject.

In Botany honorable mention may be made of Professor N. M. Blytt, and in Geology we refer to Professor Sjur Saxe, who is the author of some admirable works on the glaciers and snowfields. Professor Th. Kjerulff is also a high authority on the same subject.

Among those who have contributed to the literature of Medicine we may name Professor W. Boeck, who died in 1873, and Dr. D. C. Danielsen.

Professor P. A. Munch, who died in 1863, established a high reputation by his historical works, and Professor Sofus Bugge's researches in respect to the ancient languages have been recorded in works which are much esteemed.

The present number of "*Naturen*" now before us, which was the second issued, is printed on good paper, and is well printed. The contents are somewha popular in character, the first article being one of a series on the five senses, entitled "*Synet*" [sight] with ten illustrations. The second article on "*Lungefiske*," [Lung fishes] is also illustrated with drawings of the *Lepidosiren paradoxa* and allied forms. The number concludes with minor articles of interest.

We understand "*Naturen*" will be well patronized and we wish the promoters of the paper every success.

NOTES.

A PATENT has been granted for an electro-magnetic rock-drill. A drilling tool is directly attached to the core of axial magnets and arranged to impart to said core a reciprocating motion. The current is shifted alternately to the coils.

AN application for a patent for the photophone was filed at Washington on the 28th of August, 1880, by Bell. The Patent Office *Gazette* of the 7th of December shows that the patent has been granted.

PHYSICO-CHEMICAL ANALYSES OF SOILS.—M. Pellegrini has compared the methods of Schlœsing, Nœbel, and Masure, and obtained such differences as clay, 37 and 87; sand, 1.5 to 28. He considers Schlœsing's method the most satisfactory.

The conclusion arrived at by G. Hauser, in regard to the organ of smell in insects is as follows: The organ of smell, in all the Orthoptera, Pseudoneuroptera, Diptera and Hymenoptera, also in a large part of the Lepidoptera, Neuroptera and Coleoptera, consists: 1. Of the antennal nerve. 2. Of a terminal perceptive apparatus consisting of rod bearing cells arising from hypodermic cells, with which a nerve-fibre connects. 3. Of an apparatus consisting of a pit or a cone filled with serous fluid which may be considered as simple infolds and projections of the epidermis.

Considerable encouragement to naturalists living in cities should be afforded by the amount of botanical work executed by Mr. L. P. Gratacap, on a few vacant lots, in the City of New York, known as Manhattan Square. A short time since the inequalities of the ground were filled up by earth which was carted in, the result being the introduction of an army of plants which soon covered the ground with a mantle of waving weeds. A careful examination of these plants showed them to be composed of 35 orders, of 99 genera, and 117 species.

M. Levoiturier, an entomologist, of Elbeuf, has communicated to the Sociétié d'Acclimation the result of an enquiry as to Coleoptera found in wools from different parts of the world. The author's list is quite a long one, and it is stated that by its inspection the origin of a particular sample of wool may be ascertained, which knowledge is important, as the net return from wool, after scouring, varies greatly. The list comprises, for Australia, 47 species of insects; Cape of Good Hope, 52; Buenos Ayres, 30; Sapin, 16; Russia, 6.